THE INTEGRATION OF CAPITAL MARKETS:

COINTEGRATION ANALYSIS OF THE STOCK MARKET INDICES AMONG CHINA, HONG KONG, SINGAPORE, TAIWAN, JAPAN, UK AND US ECONOMIES

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SUMMARY

With the development and liberalization of China stock market, especially after the entry into WTO, there has been an increase in investors' interest in investing China stock market. Is this possible that use China stock market to realize international diversification is a source of continuing controversy in both academic and business circles. The objective of this thesis is to explore the pattern and the extent to which the stock price movements in Shanghai Stock Exchange are linked with the international stock markets.

We use cointegration analysis and Granger causality technique to test the long-run equilibrium relations and causal relations between China, US, UK, Japan, Hong Kong, Taiwan and Singapore stock markets. The messages from the results show that China stock market is segmented globally, but appears integrated within the region before 1997. The results may be due to the open extent of Chinese economy and the social-economic, cultural and geographical reasons. While, after 1997 the results report that China stock market has cointegration (long-run equilibrium relationship) with all the other six markets at 5% significant level. If we choose critical value at 1%, Hong Kong and Singapore markets have cointegration with China stock market. Taiwan stock market is very close to the critical value at 1% level. So we can say with the reform and open policy, in particular after China entry into WTO China stock market had been more and more integrated with the international stock markets, especially highly integrated with its regional counterparts. We further employ ECM and VAR to test the causal relations between them; the results show that before 1997, Granger cause exists between Japan, Taiwan and China stock market mutually, while unidirectional causal relation is found from Hong Kong stock market to China stock market. After 1997, all the six stock markets have causality

relationship with China stock market unilaterally. The unidirection of causal relations is from the six stock markets to China stock market. On the one hand, the above results verify that the more social-economic relationship, trade and culture relationship, the more linkage between the national stock markets. On the other hand, a possible reason for the unidirectional relations may be due to the fact that the stock price movements in the Shanghai market are driven more by policy or regulatory changes than by changes in fundamental economic factors.

In summary, our empirical results suggest that Chinese economy has been integrated into the global economy gradually companied by the financial integration into the world capital markets and the significant price co-movements of national stock markets could be related to geographical proximity, partnerships in trade, and cultural similarity.

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Chapter 1 Introduction

From 1987 to the present, China has experienced unprecedented growth in Gross Domestic Product (GDP), growing at an average rate of 9% per year. The reform has affected all sectors of the economy and has lifted an enormous number of people out of starvation and into the consumer middle class. The commercialization of the Chinese economy has also opened it up to foreign direct investment. The continuous market development has been impressive by any standards. In the meanwhile, with the open policy Chinese economy has been more and more integrated into the global economy. Whether the degree of correlation between the returns of the market indices in China and major developed countries and other regional markets is comparable to that of economic integration between these economies, or whether investment in China stock market can diversify the risk of portfolio investment will draw the global investors' attention. Because China stock market has been formed relatively recently, and to our knowledge, its possible integration, both with the countries in South-East Asia and globally, has not been examined in the literature. So we choose China stock market as the major target to study the long-run comovements of international stock prices and stock market integration.

1.1. The development of Chinese economy after the reform and open policy

Since China inaugurated the reform and opening-up in late 1970s, she has steadfastly developed foreign trade and actively attracted foreign investment. China's trade value takes the fifth place in today's world. Its foreign capital attraction ranks as the foremost among all the developing countries with an annual FDI of about USD40 billion for the past few years. Reform and opening-up have not only promoted the sustained, swift and sound development of China's national economy, but also helped restructure its economic system. In addition, this process has contributed to the prosperity of Asian economy and the world economy. For example, economic output in Japan, Hong Kong and Singapore is forecast to be 2.2% to 5.5% higher than the case of non-accession.

1.2. Chinese economic integration into the global economy

In the last two decades, the economy of modern China has been more and more integrated into the global economy, especially with United States (US), United Kingdom (UK), Japan, Hong Kong, Taiwan, and Singapore. For example, bilateral trade turnover (the sum of exports and imports) between China and US grew from USD1 billion in 1978 to USD116 billion in 2000[1]. China has become the eighth largest international market for firms of United States in 2000. Moreover, exports of United States to China grew rapidly from 1990 to 2000. As in January 2003, exports from United Kingdom to China was USD270 million and the imports from China was USD706 million. The exports and imports between China and Japan are USD4061 million and USD5136 million respectively. In 1999, Taiwan’s export and import to Mainland China was USD36 billion and USD187 billion respectively. At the same time, Hong Kong’s import from China reached HK$606 billion, or 43% of its total import. Hong Kong’s export to China accounted for 30% of its total export, making China its second largest export destination. The sum of exports and imports add up to USD6212 million by the first month of 2003. Meanwhile, 47% of the foreign direct investment in China came from Hong Kong and Taiwan. According to Wei (1995), over 50% of the overseas direct investment in China between 1984 and 1990 was from Hong Kong mainly due to their linguistic and cultural

[1] All data cited in this paragraph are from China Statistics Yearbook 2000 and website: www.moftec.gov.cn.

relations. Hong Kong and Taiwan are the two most important sources of direct investment in China.

1.3. The development of China stock market

The growth of Chinese economy claims the development of China stock markets. The increase in the market capitalization and number of listed companies is summarized in Table 1.

Table I: development of Shanghai Stock Exchange

Year	Market Value for Stocks (RMB100 Mil.)	Number of Listed Companies
1991	29.43	8
1992	558.4	30
1993	2195.7	106
1994	2600.13	171
1995	2525.66	188
1996	5477.81	293
1997	9218.07	383
1998	10625.92	438
1999	14580.47	484
2000	26930.86	572
2001	27590.56	646

Source: Fact book 2002, Shanghai Stock Exchange.

In December 1990, Shanghai Stock Exchange (SHSE) and later in July 1991 Shenzhen Stock Exchange (SZSE) were established to allow investors and enterprises to participate in stock trading. The shares traded on China stock markets can be classified into a few main categories. For example, A-Share is exclusively sold to Chinese nationals and available only to domestic investors. B-Shares are denominated in RMB but traded and purchased in foreign currency exclusively by foreigners. H-Shares are issued by Chinese companies and trade in the Hong Kong Stock Exchange (HKSE). L-Shares are the stocks of Chinese enterprises that have been chosen to list in the London Stock Exchange (LSE). N-Shares are issued by Chinese companies and traded in the New York Stock Exchange in the form of American Depositary Receipts. S-Shares are floated by Chinese companies and traded in the Singapore Stock Exchange. Red-Chips are listed on the HKSE. Red-Chip issuers are typically companies controlled by the government or state-own Enterprises but incorporated in Hong Kong.

China stock markets have developed rapidly especially in recent years. By 2000, the total market capitalization of China stock markets has reached RMB4809 billion which was higher than Taiwan, South Korea and Singapore. In 2001, the number of investors at Shanghai Stock Exchange was 34,296,000 with a growth rate of 15.6%. The total market capitalization of Shanghai Stock Exchange hit RMB2.7 trillion or 28.7% of the country's GDP in 2001. At the same time, capital raised from SHSE surpassed RMB380 billion. Shanghai Composite Index was compiled to reflect the stock price movements in SHSE. It is a weighted average stock price index with the number of shares issued by all listed companies as weight. It uses July 15, 1991 as base day and has been officially published since July 15, 1991. Table I shows the development of Shanghai stock market.

After the entry into WTO, China will further open its capital market and get greater opportunities as well as challenges to further boost the market construction and regulation, so whether investing in China stock market is feasible and maybe lead to lower portfolio risk for the global investor if it is actually relatively uncorrelated with the major developed markets and regional markets even though more closer socioeconomic relationship between China and the whole word is a new research area.

1.4. The objective of the thesis

This thesis aims at investigating whether the linkages exist among the typical stock markets of China, Singapore, Taiwan, Hong Kong, US, UK and Japan and reflects economic integration among these seven economies because China stock market has been formed relatively recently, and to our knowledge, its possible integration, both within the region as well as globally, has not been examined in the literature.

For that purpose, we first examine co-movements between China and the six stock markets by employing the Engle-Granger (1987) two-step cointegration technique. Next, we employ the minimum final prediction error criterion to determine the optimum lag structures (Hsiao, 1979 and 1981) and finally we use the error correction model (ECM) and vector autoregressive models (VAR) to find the causal relationships between China stock market and the other six stock markets. Our results provide evidence that before 1997 the linkages of China stock market with its regional emerging markets and other developed markets appear to be relatively weak. Apparently China stock market still isolated from the core of major international markets, relatively integrated with other Asian emerging markets (Japan, Hong Kong and Taiwan stock market). Hong Kong stock market Granger causes China stock market, while Japanese and Taiwan stock market have mutually Granger causality with China stock market. The open and development extent of China stock market can support the results. For China itself, China stock market is sensitive to changes in its political structure, has considerable growth potential, but also need to develop structural relations with major foreign markets and other regional stock exchanges. In contrast, after 1997 all six markets are cointegrated with the China stock market from 1997 to 2003. Their close social-economic, trade and culture relationships with China supported this important implication to the global investors. Furthermore, there is unilateral transmit from the six stock markets to China stock market due to policy factors and regulation constraints.

1.5. The organization of the thesis

The rest of the thesis is organized as follows. Chapter 2 provides a literature review on market co-movements. Chapter 3 presents the data, methodology and Chapter 4 reports the empirical results and provides interpretation. Chapter 5 summarizes the study with conclusion.

Chapter 2 Literature Review

Capital markets across countries or regions may exhibit varying degrees of integration (segmentation). Theoretically, market linkages primarily stem from the "law of one price" that identical assets (physical or financial) should bear the same price across countries after adjusting for transaction costs. Rational (well-informed) investors would, or perhaps should, arbitrage away price disparities, leading to more integrated markets. The Degree of integration among different economies is an important issue in international economics. Much of the literature in this area has concentrated on measuring international financial integration. On the one hand, the presence of co-movement among national stock markets limits the benefit, but on the other hand, the implication of co-movements across financial markets of different countries is an attempt to predict the stock index of one country based on the stock index of an economically dominant country.

2.1. The studies of comovements of developed stock markets in the world

The presence of comovements among national stock markets limits the benefit of international diversification. A number of studies have examined co-movements of international stock markets. A considerable amount of work has been done on the interrelationships among the world equity markets, especially focus on the major developed markets like United States and Japan.

The performances of developed markets draw the world attention before and after the crash of 1987. The predominant feature of the Crash in 1987 was its global scale. The equity markets of the world reacted to the collapse of the Dow Jones index of the New York Stock Exchange with their own version of a crash. The Crash of October 1987 has made people realize that various national equity markets are so integrated. The developed markets e.g., the US exert a strong influence on other smaller markets. Eun and Shim (1989) use vector autoregression to study the interdependence among world equity markets and find evidence of co-movements among these markets with the US. By using a single equation model, Cheung and Mak (1992) examine the causal relationships between the Asian markets and the developed markets. They also find that the US market is an important global factor. Lee and Kim (1994), following a correlation approach, examine the effect of the October 1987 crash on the co-movements among national stock markets. They find that national stock markets became more interrelated after the crash, and the strengthening co-movements among national stock markets continued for a longer period after the crash. In addition, it is shown that the co-movements among national stock markets were stronger when the US stock markets more volatile.

Another approach in investigating the co-movement relationship between the developed countries' stock markets is the volatility spillover effect among national stock markets. Goodhart (1988); King and Wdhwani (1989); for example, investigate the short-run-interdependence of price volatility (or spillovers) across three major stock markets, partly because such volatility spillovers could represent indirectly a causal phenomenon across markets that trade sequentially. Hamao, Masulis and Ng (1990) study the stock markets of US, Japan and UK, using an Autoregressive Conditional Heteroskedastic (ARCH) family of statistical models on daily opening and closing prices. Some evidence is provided for spillovers of volatility from New York to other markets, but not in the opposite directions. Ng, Chang and Chow (1991) find volatility spillovers from US to the Pacific Basin countries. Lin, Engle, and Ito (1991), however, argue that volatility spillovers between the US and Japan become symmetric when the problem of stale quotes or non-synchronous trading in opening prices is explicitly taken into account. Campbell and Hamao (1992) explore the extent to which US and Japanese stock markets are integrated by studying the predictability of monthly returns on US and Japanese equity portfolios. Kasa (1995) uses the monthly stock return data from US, Japan, and Great Britain for the period from 1980 to 1993 and finds that the conclusion of market integration depends sensitively on the assumed variation of the (unobserved) common world discount rate. The more volatile is the discount rate the more likely are markets to be integrated. Darbar and Deb (1997) examine the co-movements of equity returns in major international markets by characterizing the time-varying cross-country covariances and correlations. Using a generalized positive definite multivariate generalized autoregressive conditional heteroscedasticity (GARCH) model, they find that the Japanese and US stock markets have significant transitory covariance but zero permanent covariance. Bae and Cheung (1998) find that the spillover effects from the US to Hong Kong have become more prominent after the October 1987 crash.

Time-series analysis of the international co-movements of the stock markets is another research area. Jeon and von-Furstenberg (1990) apply the VAR approach to investigate the interrelationship among stock prices in major world stock exchanges. The impulse response function analysis showed that the degree of international co-movement in stock price indices has increased significantly since the crash. Koop (1994) uses a variety of different objective Bayesian methods to analyze unit root and cointegration properties of two different finance data sets and concluded that there are no common trends in stock prices or exchange rates across countries. In addition, Corhay, Rad and

Urbain (1995) study the stock markets of Australia, Japan, Hong Kong, New Zealand and Singapore; find no evidence of a single stochastic trend for the countries. Christofi and Pericli (1999) investigate the short run dynamics between five major Latin American stock markets (Argentina, Brazil, Chile, Columbia, and Mexico) find significant first and second moment time dependencies.

There is literatures focus on price discovery in world markets in investigating international co-movements. Naturally, cointegration and error correction modeling provides a useful framework for analyzing price adjustments in internationally linked markets. Mclnish and Wood (1992) report that regional exchanges are not free riders on primary exchange, and they contain information that is relevant for traders at primary markets (Garbade and Silber 1979).

2.2. Recent studies of the emerging markets in the world

In recent years, new capital markets have emerged in many parts of the world and foreign capital controls have also been relaxed to a certain extent. With this relaxation of capital controls, there has been an increase in investors' interest in international diversification as it allows investors to have a larger basket of foreign securities to choose from and add to their portfolio assets to diversify investment risk. The co-movements in emerging markets that have been investigated are broad. A number of studies have examined co-movements in stock returns with reference to the expected return and diversification benefits of emerging-market investments (Harvey 1991; Wilcox 1992).

Asian capital markets are new stars among the emerging markets; many studies have been done in the 1990s and thereafter to study the co-movements between Asian markets and the stock markets in developed countries. Chan et al. (1992) conduct unit root and pairwise cointegration tests to examine the relationship among the Asian-Pacific markets and conclude that these Asian markets are not cointegrated. Chowdhury (1994) studies the relationships among four Newly Industrialized Economies (NIEs), Japan and US. He finds that US market leads the four NIEs (Hong Kong, S. Korea, Singapore, and Taiwan) and there is significant link between the stock markets of Hong Kong and Singapore, Japan and US. Phylaktis (1995) finds that there has been an increase integration of capital markets in Pacific Basin Region with US and Japan. Kwan, Sim and Cotsomitis (1995) studied the stock markets of Australia, Hong Kong, Japan, Singapore, South Korea, Taiwan, United Kingdom, United States and Germany and suggest that these markets are not weak form efficient as they find significant lead-lag relationships between these equity markets. Cashin et al. (1995) use the cointegration tests to assess the extent to which equity prices move similarly across countries and regions. They report increased integration of emerging equity markets since the beginning of 1990 via greater regionalization of national stock markets. Besides, if national stock markets are subject to a global shock that causes them to deviate from their long-run equilibrium relationship, it takes several months for the long-run relationship to reassert itself.

Chaudhuri (1997) investigates the common trends in seven Asian markets by using the Johansen cointegration methodology and reports a single trend. Palac-McMiken (1997) uses the monthly ASEAN market indices (Indonesia, Malaysia, Philippines, Singapore and Thailand) between 1987 and 1995 and finds that with the exception of Indonesia, all the markets are linked with each other and that these markets are not collectively efficient. He suggests that there is still room for diversification across these markets despite evidence of interdependence among ASEAN stock markets. Masih and Masih (1999) find high level of interdependence among markets in Thailand, Malaysia, US, Japan, Hong Kong, and Singapore from 1992 to 1997. Johnson and Soenen (2002) study the equity market integration between the Japanese stock market and the other twelve equity markets in Asia. They find that the equity markets of Australia, Hong Kong, Malaysia, New Zealand, and Singapore are highly integrated with the stock market in Japan. They also find evidence that these Asian markets are becoming more integrated over time and that a higher import share as well as a greater differential in inflation rates, real interest rates, and GDP growth rates have negative effects on stock market co-movements between country pairs.

It appears that previous empirical studies on the relationship between world stock markets do not provide consistent results. The reasons for the inconsistent results are numerous, including the choice of markets, different sample periods, different frequency of observations, and the different methodologies employed. Looking at the increasingly importance and integration of Chinese economy in the world economy, this study takes China into account which has not been previously examined. The purpose of assessing co-movements between China and the six stock markets is unique to this study.

Chapter 3 Data and Methodology

3.1. Data

The data used in this study consist of weekly stock indices of the major stock exchanges in China, United States, United Kingdom, Japan, Taiwan, Singapore and Hong Kong. Specifically, the indices sampled include Shanghai Composite[2] (Shanghai Stock Exchange), the S&P 500 Composite (New York Stock Exchange), FTSE 100 (London Stock Exchange), Nikkei 225 Stock Average (Tokyo Stock Exchange), Taiwan SE Composite[3] (Taiwan Stock Exchange), Straits Times Index (Stock Exchange of Singapore) and the Hang Seng (Stock Exchange of Hong Kong), all expressed in terms of local currencies. We use the US stock market (S&P500), the UK stock market (FTSE 100) and the Japanese Stock market (Nikkei 225 Stock Average) represent the major world markets in this thesis in viewing the growing evidence that assigns considerable weight to these three markets in the global capital market[4]. On the other hand, Hong Kong stock market (Hang Seng), Taiwan Stock market (Taiwan SE Composite) and Singapore stock market (Straits Times Index) (New) are chosen as the regional counterparts of China stock market. Stock returns are computed as the percentage log difference of Wednesday closing price. The data are obtained from DataStream, total number of observations is 331 and it covers the period Jan 02, 1991 through April 30, 2003. Weekly indices are used because a representation bias due to some thinly traded stocks, i.e., the problem of non-synchronous

[2] Shanghai composite index compiled by the SSE to reflect share price movement is issued along with instant securities trading. It is a weighted average share price index with the number of shares issued of all listed shares including A-shares and B-shares as weight number. It uses July 15, 1991 as base day and has been officially published since July 15, 1991.
[3] Because TAIWAN SE COMPOSITE - PRICE INDEX is only available from 03/08/94, so for the period before 1997 we use TAIWAN SE BANKING & INSURANCE - PRICE INDEX instead.
[4] See, for example, Ghosh et al. (1999), and Darrat and Zhong (2000).

trading when daily indices are in use, as daily indices may be influenced by some thinly traded stocks, is reduced with a weekly interval of the indices. An erroneous representation of the true relationships among these markets may thus result if daily indices are used (Hung and Cheung, 1995). Also, by choosing the Wednesday price, the seasonal pattern of the stock returns can be avoided. It is well known that stock returns are lower at the beginning of the week and is higher at the end of the week. For instance, Ho (1990) documents the existence of the seasonal pattern in Asia-Pacific stock returns.

Table II presents a brief description of the four emerging markets as well as the United States, United Kingdom and Japanese stock markets. All four Asian emerging markets have a huge growth potential and have already attracted a large amount of international investment. This is evidenced by the increasing number of international funds which have an explicit policy of investing their funds in these markets[5].

Table III provide some descriptive statistics for the data used. In table III, it is interesting to see that Asian markets have higher levels of risk than US and UK stock markets for the whole sample period. This is also true for each sub-period. Another interesting observation is that the mean returns of all markets before 1997 is higher than these mean returns after 1997 to a rather significant extent. We also notice that the mean return is negative for the Japanese market for the whole period and each sub-period. Among all markets, China stock market has the highest mean returns for the whole period and each sub-period and the highest level of risk for the whole period and period 1.

[5] Cheung and Ho (1991) demonstrate the benefit of investing in these AEMs.

Table II: Description of the China, US, UK, Japan, HK, Taiwan, Singapore Markets

(as of Dec31,2002）

Unit: billion in local currencies

Country	**China**	**US**	**UK**	**Japan**	**HK**	**Taiwan**	**Singapore**
Exchange	Shanghai Stock Exchange	New York Stock Exchange	London Stock Exchange	Tokyo Stock Exchange	Hong Kong Stock Exchange	Taiwan Stock Exchange	Singapore Stock Exchange
Market capitalization	2759.56	9603.3	1147.8	247860	3559	4444	318.6
Trading volumes of equity shares	4414.4	349907.8	1815	193354	1599	21981	109.4
No of listed companies	646	2783	1701	2153	812	638	521

Source: Fact book 2002, the above seven Stock Exchange Ltd.

Table III: Sample statistic of weekly index returns for the selected seven markets

Country / Period	**China**	**US**	**UK**	**Japan**	**HK**	**Taiwan**	**Singapore**
Whole sample period: Mean (%)	0.6	0.19	0.12	-0.13	0.23	___	0.09
Standard deviation (%)	7.11	2.26	2.4	3.07	3.6		3.14
Period 1 (before 1997): Mean (%)	1.02	0.28	0.23	-0.02	0.53	0.26	0.26
Standard deviation (%)	9.62	1.57	1.85	2.94	3.16	5.16	2.31
Period 2 (after 1997): Mean (%)	0.21	0.1	0.02	-0.22	0.05	-0.02	0.06
Standard deviation (%)	3.29	2.75	2.81	3.19	3.96	3.28	3.76

To examine the trend of interdependence between China stock market with the developed and emerging markets overtime, the stock indices from the sample are further sub-divided into two sub-periods: January 02, 1991 – December 25, 1996 (Period 1) and January 02, 1997 – April 30, 2003 (Period 2). Because the return of Hong Kong and 1997 Asian financial crisis abnormally influence the performance of China stock market besides the fundamental Chinese economy situation, so we use the year 1997 to separate all data into the above two sub-periods.

3.2. Methodology

3.2.1 Conventional cointegration technique

Economic theory is based on equilibrium relationships among a set of variables and statistical analyses applied to financial time series are employed to investigate such relationships. Classical statistical inference will be valid if the time series are stationary but misspecification results if the series are not stationary. To achieve stationarity, financial economists difference the variables and then use these differenced series in statistical analysis so that valid statistical inference will be achieved.

The traditional approach to investigate whether stock markets are integrated from a regional and international perspective is to use regression analysis where one evaluates the correlation of returns across markets as, for example, in Meric and Meric (1989). However, this approach is inappropriate in our case since it presupposes that the time series being examined are stationary (in levels). This presupposition is clearly violated in the case at hand since stock indices in all seven markets are non-stationary in levels. Therefore, we rely instead on the theory of cointegration discussed in Engle and Granger (1987).

The concept of cointegration, which is important in determining the presence and nature of an equilibrium economic relation, was first introduced by Granger (1981, 1986) and further developed by Engle and Granger (1987), incorporates the presence of nonstationarity, long-term relationships and short-run dynamics in the modeling process. A lengthy, detailed description of cointegration can be found in many textbooks (see Engle and Granger, 1991; Davidson and MacKinnon, 1993; Banerjee, Dolado, Galbraith and Hendry, 1993; Hamilton, 1994).

A brief overview is sufficient here, A financial time series is said to be integrated of order one i.e., I(1), if it becomes stationary after differencing once. If two series are integrated of order one, they may have a linear combination which is stationary without requiring differencing and, if they do, they are said to be cointegrated.

In studying the question of co-movements among the stock indices in China, the United State, Japan, Hong Kong, Taiwan, Singapore, the relationship between them has to be established. The model consists of the dependent variables: Taiwan, Singapore, Hong Kong, United States, United Kingdom, and Japan, and independent variables: China. The relationship can be represented by:

$$Y_t^c = a + bY_t^o + e_t \qquad (1)$$

where y_t^c denotes the Chinese stock index. The y_t^o denotes the other country's stock indices (i.e. stock indices of the United States, United Kingdom, Japan, Hong Kong, Taiwan or Singapore) and e_t denotes the error term. The statistical concept of cointegration plays a major role in determining the validity and reliability of the relationship specified above. Cointegration is thus required in order to reach the conclusion of a stable equilibrium relationship between the stock indices of China and the one of the selected markets.

In order to test for cointegration, a unit root test (Dickey Fuller and Augmented Dickey Fuller tests) first has to be performed to confirm that the variables are indeed stationary.

Cointegration tests in this thesis consist of two steps. The first step is to examine the stationary properties of the various stock indices in our study. If a series, say y_t, has a stationary, invertible and stochastic ARMA representation after differencing d times, it is said to be integrated of order d, and denoted as $y_t = I(d)$. Most non-stationary series are integrated of order one, i.e. I(1). We call a stationary series to be integrated of order zero, i.e. I(0). To test the null hypothesis H_0: $y_t = I(1)$ versus the alternative hypothesis H_1 : $y_t = I(0)$, we apply the Dickey-Fuller (1979,1981) unit root test procedure based on the OLS regression

$$\Delta y_t = b_0 + a_0 t + a_1 y_{t-1} + \varepsilon_t \qquad (2)$$

Or apply the augmented Dickey-Fuller (ADF) test based on the OLS regression

$$\Delta y_t = b_0 + a_0 t + a_1 y_{t-1} + \sum_{i=1}^{p} b_i \Delta y_{t-i} + \varepsilon_t \qquad (3)$$

where $\Delta y_t = y_t - y_{t-1}$ and y_t can be Y_t^c or Y_t^o as defined in (1). The regression in (2) allows for a drift term, a deterministic trend and a stochastic structure in the error term, ε_t. The variable p is chosen from equation (5) to achieve white noise residuals, ε_t. Testing the null hypothesis of the presence of a unit root in y_t (i.e. the series is I(1)) is equivalent to testing the hypothesis that $a_1 = 0$ in equation (2) and (3). If a_1 is significantly less than zero, the null hypothesis of a unit root is rejected. The test statistic used is the usual t-ratio, but the distribution is not the t-distribution under the null hypothesis. When p=0, the test is known as the Dickey-Fuller (DF) test. This test assumes that the residuals ε_t are independently and identically distributed. If serial correlation exists in the residuals, then p>0 and the augmented Dickey-Fuller (ADF) test must be applied. However, the ADF test loses power for sufficiently large vales of q. Because of this, an additional, alternative test proposed by Phillips and Perron (PP) (1987) which allows weak dependence and heterogeneity in disturbances is performed using the following regression:

$$y_t = b_0 + b_1 y_{t-1} + u_t \quad (4)$$

Where u_t is serially corrected. Then we test the null hypothesis $b_1 = 0$. If b_1 is significantly less than zero, the null hypothesis of a unit root is rejected.

In addition, we test the hypothesis that y_t is a random walk with drift, i.e. $(\beta_0, \alpha_0, \alpha_1) = (\beta_0, 0, 0)$ and y_t is random walk without drift, $(\beta_0, a_0, a_1) = (0,0,0)$ using the regression (2). The test statistics are the likelihood ratios Φ_3 or Φ_2 found in Dickey and Fuller (1981). The decision rule is to reject the null hypothesis if Φ_3 and Φ_2 are larger than the critical value. If both the hypotheses that $a_t = 0$ and $(\beta_0, a_0, a_1) = (\beta_0, 0, 0)$ or $(\beta_0, a_0, a_1) = (0,0,0)$ are accepted, we can conclude that y_t is I(1). If we cannot reject the hypotheses that y_t is I(1), we then test the null hypothesis H_0 : y_t = I(2) versus the alternative hypothesis H_1 : y_t = I(1). If both Y_t^c and Y_t^o are of the same order, say I(1), we then estimate the cointegrating parameter of (1) by OLS regression. If the two series are cointegrated, then the residuals of the regression from (1) will be stationary. If the two series are not cointegrated, the residuals may be integrated of order 1.

Testing for cointegration is undertaken once it is found that each series contains one unit root. The three most common tests for stationarity of estimated residuals are Cointegrating Regression Durbin-Watson (CRDW), Dickey-Fuller (CRDF), and Augmented Dickey-Fuller (CRADF) tests. Engle and Granger (1987) suggest that the CRDW test might be used to obtain a quick approximate result. Although the power of the CRDW test is greater than the DF type tests for the case where the alternative hypothesis is a simple stationary first-order autoregressive process, but it is sensitive to the dynamic structure of the error term. Thus, the CRDF and CRADF tests that are based on the OLS regression

$$\Delta\widehat{e}_t = \gamma\widehat{e}_{t-1} + \sum_{i=1}^{p}\gamma_i\Delta\widehat{e}_{t-1} + \xi_t \qquad (5)$$

should be employed, where $\hat{e}_t$ are residuals from the cointegrating regression and p is chosen to achieve empirical white noise residuals. The null hypothesis of non-cointegration is rejected if the t-ratio is less than the relevant critical value. Engle and Granger (1987) have tabulated these critical values for the case where p=0 (CRDF) and p>0 (CRADF) for the bivariate regression with a sample of 100 observations.

More details in cointegration modeling can be found in Manzur et al. (1999). When a set of variables is cointegrated, a vector autoregression in first differences will be missspecified because first differences will be misspecified because first differencing of all the nonstationary variables imposes too many unit roots and any potentially important lone-term relationship between the variables will be obscured. The inference based on this model may lead to incorrect conclusions (see Granger (1981) and Sims, et al. (1990)).

However, there exists an alternative representation, an error correction representation of such variables, which takes account of a short- and long-run equilibrium relationship shared by those variables. Once it is established that the series are cointegrated, their dynamic structure can be exploited for further investigation. Engle and Granger (1987) show that cointegration implies, and is implied by, the existence of an error correction representation of the indices involved. An error correction model (ECM) abstracts the short- and long-run information in the modeling process.

Our interest is to uncover linkage between China stock market and the markets of other countries that has very close socio-economic relationship with China and the interrelations among the other six economies.

3.2.2. Vector Autoregression Model in the conventional cointegration framework

Once the cointegration relation between China stock market and the markets of other six countries has been decided—exists or not, we can adopt the bivariate VAR model or bivariate ECM to test the Granger causality. The VAR model has the advantage of not having an underlying theory and does not need any assumptions about the values of the exogenous variables. If the cointegration does not exist between the two markets, we employ

$$\begin{aligned}\Delta y_t^c &= a_0 + \sum_{i=1}^{n} a_{1i}\Delta y_{t-i}^c + \sum_{j=1}^{m} a_{2j}\Delta y_{t-j}^o + u_{1t} \\ \Delta y_t^o &= b_0 + \sum_{i=1}^{n} b_{1i}\Delta y_{t-i}^o + \sum_{j=1}^{m} b_{2j}\Delta y_{t-j}^c + u_{2t}\end{aligned} \tag{6}$$

where y_t^c and y_t^o represent index of China stock market and one of the other six stock markets respectively, u_t is error term. We test the null hypothesis, H_0 : $a_{21} = a_{22} = \cdots = a_{2m} = 0$ which implies that one of the six stock markets does not Granger cause China stock market. Similarly, we test H_0: $b_{21} = b_{22} = \cdots = b_{2m} = 0$ to confirm that China stock market does not Granger cause one of the other six stock markets as well.

3.2.3. Error Correction Model in the conventional cointegration framework

If the series are cointegrated, there is a long-term, or equilibrium, relationship among the series. Their dynamic structure can be exploited for further investigation. An error correction model (ECM) abstract the short- and long-run information in the modeling process. The ECM first used by Sargan (1964) and later popularized by Engle and Granger (1987) corrects for disequilibrium in the short run. Engle and Granger (1987) show that cointegration is implied by, the existence of an error correction representation of the indices involved. Cointegration implies that the series have an error correction representation and, conversely, and ECM implies that the series are cointegrated. An important theorem, known as the Granger representation theorem, states that if two variables Y and X are cointegrated, then their relationship can be expressed as ECM. An error correction term (e_t) is added to the equation to test the Granger causality.

$$\Delta y_t^c = a_0 + ae_{t-1} + \sum_{i=1}^{n} a_{1i}\Delta y_{t-i}^c + \sum_{j=1}^{m} a_{2j}\Delta y_{t-j}^o + u_{1t}$$

$$\Delta y_t^o = b_0 + be_{t-1} + \sum_{i=1}^{n} b_{1i}\Delta y_{t-i}^o + \sum_{j=1}^{m} b_{2j}\Delta y_{t-j}^c + u_{2t} \tag{7}$$

The above equation provides a better representation of the stochastic dynamic relationship between the series by enlarging the information set. For example, the last period's equilibrium error is incorporated through the error correction term. Short-run deviations in one period are adjusted through lagged variables in the next period. If the intercepts from the equation (7) are found to be less than twice their standard errors for all series, this implies the absence of a linear trend in the data generating process. The error correction term is negative (and always more that twice its standard error) which indicates a tendency towards mean reversion. If the change in the corresponding regressand is above its average value, the error correction term is positive. In this case, the time series will move downward to follow the long-run equilibrium attractor, making the coefficient negative. If the time series is below its average position the error correction term is negative. However, it will move upward to follow the long-run equilibrium attractor, and the coefficient will be negative. These coefficients measures the speed with which the system moves toward its equilibrium relationship in the long run. The coefficients on the error correction term, being negative and statistically significant, imply they are restoring an equilibrium relationship in the long run. The short-run influences are judged by the lagged variables. If there are some influences to be statistically significant, it implies a tendency for market movement to be persistent in the short run. Inclusion of the short-run variables is essential to mitigate the possibility of misspecification of the model. The equation (7) incorporates both the short-run and long-run information in modeling the data.

According to Engle and Granger (1987), the existence of the cointegration implies causality among the set of variables as manifested by $|a| + |b| > 0$, a and b denote speeds of adjustment. If we do not reject H_0: $a_{21} = a_{22} = \cdots = a_{2m} = 0$ and a = 0, it means that one of the six stock markets do not Granger cause China stock market. Similarly, do not reject $H_0: b_{21} = b_{22} = \cdots = b_{2m} = 0$ and b=0 suggests that China stock market does not Granger cause one of the other six stock markets.

3.2.4. Minimum Final Prediction Error Criterion

Since results from VAR or ECM may be sensitive to the lag structure chosen for the underlying testing models, we determine the proper lag profiles on the basis of the minimum final prediction error criterion. For VAR model, according to Hsiao (1979 and 1981) the minimum final prediction error criterion is used to determine the optimum lag structures in the regressions (8) and (9) respectively:

$$\Delta y_t^c = a_0 + \sum_{i=1}^{n} a_{1i} \Delta y_{t-i}^c + \sum_{j=1}^{m} a_{2j} \Delta y_{t-j}^o + u_{1t} \qquad (8)$$

$$\Delta y_t^o = b_0 + \sum_{i=1}^{n} b_{1i} \Delta y_{t-i}^o + \sum_{j=1}^{m} b_{2j} \Delta y_{t-j}^c + u_{2t} \qquad (9)$$

where n and m are lags in the left hand and right hand side variables respectively; and u_{1t} and u_{2t} are disturbance terms obeying the assumptions of the classical linear regression model. The final prediction error statistic of Δy_t^c for n lags of Δy_t^c and m lags of Δy_t^o is

$$FPE_{\Delta y_t^c}(n,m) = \frac{(N+n+m+1)\sum(\Delta y_t^c - \Delta \hat{y}_t^c)^2}{(N-n-m-1)N}$$

where N is the number of observations. The FPE statistic for Δy_t^o is found by the same way. To determine the minimum $FPE_{\Delta y_t^c}$, the first step is to run the regression in equation (8) excluded Δy_t^o and only lags of Δy_t^c included. We start from m=0 and n=1 and calculate $FPE_{\Delta y_t^c}(1,0)$. We proceed the same step until n=n* where FPE is minimized for m=0. Then by holding n=n*, we systematically lag m until m=m* minimizes the FPE. The same procedure is repeated with equation (9) where n=n** and m=m** minimize $FPE_{\Delta y_t^o}(n,m)$. The same lag deciding procedure is used for ECM model.

3.2.5. Fractional cointegration

This thesis also departs from the previous studies by relaxing the strict I(0) or I(1) distinction of the equilibrium error, using fractional cointegration to test whether the equilibrium error is mean–reverting or not for the case of non-existing strict cointegration. The regression equation (1) is known as cointegration regression. If there exists parameters **a** and **b** such that process e_t in equation(1) is process e_t in equation(1) is stationary(I(1))(d=1), then the two processes Y_t^c and Y_t^o are said to be cointegrated in the conventional sense.

Cheung and Lai (1993) define two I(1) processes to be fractionally cointegrated if the fractional parameter d of the residual process e_t is less than unity (i.e. d<1) even if d is not equal to 1. When d<1, e_t is said to be a mean-reverting process in the sense that its infinite cumulative impulse response is zero, which implies that there is no lone-run impact of an innovation on e_t . However, when 0.5<d<1, the process e_t is still nonstationary even if the process is mean-reverting, On the other hand, when 0<d<0.5 is stationary as well as mean-reverting, known as a long memory process.

In this thesis, we refine the definition proposed by Cheung and Lai (1993) by imposing the condition that the cointegrating relationship should be stationary, i.e., the fractional parameter d of the residual process e_t should be less than 0.5. In other words, according to our definition, the two non-stationary processes are said to be fractionally cointegrated if the residual process e_t is stationary (d<0.5) in addition to being mean-reverting.

It is important to realize that, in general, the cointegrating relationship between financial variables is an equilibrium condition. Therefore, the mean-reverting equilibrium relationship (as implied by d<1) is less desirable than a stationary one especially when dealing the financial variables. This assertion can be supported as follows:

1) First, if the cointegrating relationship is mean-reverting but not stationary, then a disequilibrium condition, represented by a non-zero e_t, in any period will take a very long (infinite) time to disappear. However, a disequilibrium condition in financial markets, in general, implies the existence of some sort of arbitrage opportunity and should disappear within a very short period of time.
2) Second, if the cointegrating relationship is stationary when the cointegrating relationship will hold on average with finite variance around the equilibrium condition. This implies the mean of e_t is zero with finite variance. However, if the cointegrating relationship is only mean-reverting but not stationary, the variance of e_t is undefined (infinitely large).
3) Finally, when analyzing but the equilibrium relationship between two financial time series, we are not only interested in finding whether the equilibrium relationship exists but we are also interested in the specific form of the equilibrium condition. In terms of equation (1), we might be interested in resting specific restrictions on **a** and **b**, such as **a=0** and **b=1** (the two series are equal in equilibrium). However, if the cointegrating relationship is only mean-reverting but

not stationary, then conventional tests (such as t-test, F-test) on **a** and **b** cannot be applies because the distribution of the statistics are non-stationary. Furthermore, since no asymptotic distribution exists, any asymptotic tests will be meaningless.

Therefore, a stationary (rather than simply mean-reverting) relationship between non-stationary variables is a better definition of fractional cointegration. We now approach the issue of testing for fractional cointegration. Following Engle and Granger (1987), fractional cointegration can be tested using a two step procedure. In the first step, the cointegrating regression equation (1) can be estimated using the OLS method. Once the regression equation (1) is estimated, the second step involves testing for the fractional parameter d of the residual process e_t obtained from equation (1). The GPH method can be used in the estimation of d. Once the fractional parameter d is estimated, the existence of fractional cointegration can be tested. Following the refined definition presented above, the two non-stationary progresses are said to be fractionally cointegrated if the fractional parameter d of its OLS residual is less than 0.5. Hence, the fractional cointegration test estimates the value of the fractional parameter of the cointegrating regression residual.

Geweke and Porter-Hudak (1984) (GPH) propose a semi-nonparametric method for the estimation of d, which involves the use of an OLS regression based on a periodogram, specifically， they consider the following OLS regression equation:

$$\ln(I(\lambda_j)) = \alpha - d\ln(4\sin^2(\frac{\lambda_j}{2})) + \varepsilon_{j,} \qquad \text{j= 1,… ,g(T),}$$

where I(λ_j) is the periodogram of e_t evaluated at the harmonic ordinates $\lambda_j = 2\pi j / T$ and the sample size g(T) is an integer such that $\lim_{T\to\infty} g(T) = \infty$ and $\lim_{T\to\infty}(g(T)/T) = 0$, It is important to note that the sample size for the OLS regression is given by g(T) whose value depends on the value of u. Since one can choose different values of u, we can get different estimates of the fractional parameter for the same process. In empirical analysis, the sample size g(T)=T^u is used with u ranging from 0.5 to 0.8. In the calculation of the standard errors, one can use the theoretical variance of the error term ξ, which is given by $\pi^2/6$ (see GPH).

Because GPH is the most common method to estimate in empirical studies, we adopt it in this thesis. The GPH test can also be used as a test of the unit root hypothesis with I(1) processes imposing a test on d(GPH) from the first-differenced form of the series being significantly different from zero. In this respect, the GPH procedure poses an alternative viewpoint from which to scrutinize the unit root hypothesis.

Another method to estimate d is ML technique. The ML technique involves minimizing the negative of the frequency domain log-likelihood function given (apart from an irrelevant constant) by

$$-\ln L(d,\sigma^2) = \frac{1}{2}\sum_{s=1}^{T=1}\left[\ln f(\lambda_s) + \frac{I_T(\lambda_s)}{f(\lambda_s)}\right],$$

where $\lambda_s = 2\pi s/T$ and $I_T(\lambda_s)$ is the periodogram, which, in turn, is given by

$$I_T(\lambda) = \frac{1}{2\pi T}\left|\sum_{j=1}^{T}(y_j - \bar{y})e^{ij\lambda}\right|^2$$

$$= \frac{1}{2\pi T}\left\{\left[\sum_{j=1}^{T} y_j \cos(j\lambda_s)\right]^2 + \left[\sum_{j=1}^{T} y_j \sin(j\lambda_s)\right]^2\right\}$$

The information matrix is given by

$$I(\theta) = \frac{1}{2}\sum_{s=0}^{T-1}\frac{1}{f(\lambda_s)^2}\left[\frac{\partial f(\lambda_s)}{\partial\theta}\right]\left[\frac{\partial f(\lambda\ )}{\partial\theta}\right]^t$$

where

$$\frac{\partial f}{\partial \sigma} = \frac{2\sigma}{2\pi} 2^{-d} (1 - \cos(\lambda_s))^{-d}$$

and

$$\frac{\partial f}{\partial d} = \frac{\sigma^2}{2\pi} (2 - 2\cos(\lambda_s))^{-d} \ln(2 - 2\cos(\lambda_s))(-1)$$

and θ=(d σ)^t is the unknown parameter vector. The ML estimation of the parameters can be obtained using various numerical techniques that are available. The covariance matrix can be obtained from the information matrix and can be used for the testing various hypotheses regarding the values of the parameters. In testing hypotheses regarding d, one can also use the well-known asymptotic result that

$$\sqrt{T}(\hat{d} - d) \Rightarrow N(0, \frac{6}{\pi^2})$$

Therefore, the asymptotic standard deviation of $\hat{d}$ is given by $\sqrt{6/T\pi^2}$. Note that this method only calculates a single estimate of d and therefore eliminates the problem of different estimates of the fractional parameter (depending on the value of u chosen) when using the GPH method.

Chapter 4 Empirical results and interpretation

4.1. Empirical results and interpretation for the period before 1997

4.1.1. The empirical results of unit root and cointegration

The results of testing the order of integration of the seven time series for the period from January 1, 1992 to December 25, 1996 are shown on Table 1. At both 1% and 5% significant level, we can not reject that there are unit roots for all the seven stock indices in our sample. So all indices are I(1). Because all time series follow unit root, then we examine the price linkages of China within Asian stock markets and investigate its sensitivity to prices movements in major developed stock markets. In other words, we can proceed to test if the national equity market indices form a cointegration relationship with a stationary error term. Briefly, we firstly estimate equation (1), and then conduct the unit root test on the residuals from the equation (5) to test the cointegration. Table 2 shows that Japan, Hong Kong and Taiwan stock market are cointegrated with China stock market at 5% significant level. US stock market and UK stock market are very close to the 5% significant level to be cointegrated with China stock market, but haven't reached it. Apparently China stock market still isolate from the core of major international markets, preliminary inspection suggests that it is sensitive to the close economic and cultural relationship with major foreign markets and other regional stock exchanges.

Table 1: Unit Root Tests for the weekly stock indices of China, US, UK, Japan, Taiwan, Hong Kong, and Singapore stock markets for the period of 02/01/1991-25/12/1996 (In domestic currencies)

Country	Variable	DF	ADF	Φ_2	Φ_3	PP
China	Shanghai Composite	-1.92	-2.06	0.99	2.18	-2.511701
US	S&P 500	-1.04	-1.04	6.2	1.02	0.744099
UK	FTSE 100	-2.95	-2.95	2.69	4.37	-1.918109
Japan	Nikkei 225 Stock Average	-2.19	-2.19	0.38	2.7	-2.258252
Taiwan	Taiwan SE Banking & Insurance	-2.34	-2.34	0.59	3.12	-2.557125
Hong Kong	Hang Seng	-2.56	-2.56	3.92	3.55	-2.414081
Singapore	Straits Times Index	-2.09	-2.09	2.08	2.91	-2.252085

DF is the Dickey-Fuller t-statistic; ADF is the augmented Dickey-Fuller statistic.

DF & ADF for n=250 critical values at 1% = -3.99 and at 5% =-3.43, from Table D.7, Gujarati (2003), Basic Econometrics, 4th ed.

Φ2 and Φ3 are the Dickey-Fuller likelihood ratios. The critical values for them at 5% are 4.75 and 6.34 and at 1% are 6.22 and 8.43 respectively, for n=250.

For PP Test Statistic, MacKinnon critical values are used for rejection of hypothesis of a unit root. 1% and 5% critical value are -3.9889 and -3.4247. Lag truncation for Bartlett kernel: 5

Table 2: Cointegration Results between China stock market and the selected six economies

(In domestic currencies)

Country	Model	R^2	CRDF	CRADF
number of observations:339				
Period:02/01/1991-25/12/1996				
Country	**Model**	$\mathbf{R^2}$	**CRDF**	**CRADF**
US	Y(China)=-3.83366+1.64441Y(US)	0.3377	-1.9	-1.9
UK	Y(China)=-10.78431+2.13418Y(UK)	0.3598	-1.88	-1.88
Japan	Y(China)=39.52516-3.35208Y(Japan)	0.4271	-2.33*	-2.33*
Taiwan	Y(China)=4.44146+0.27580Y(Taiwan)	0.0194	-2.13*	-2.07*
Hong Kong	Y(China)=-4.43684+1.20937Y(HK)	0.5643	-2.05*	-2.05*
Singapore	Y(China)=5.14272+1.56554Y(Singapore)	0.2998	-1.68	-1.68

CRDF is the cointegrating regression Dickey-Fuller statistic for stationarity of the estimated residuals.

CRADF is the comparable test statistic for the augmented Dickey-Fuller.

CRDF & CRADF critical values at 5% = -1.95*, 1% = -2.58** from Table D.7, Gujarati (2003), Basic Econometrics, 4th ed.

4.1.2. Interpretation of cointegration results

The importance of US stock market and UK stock market is not present for the period of January 1 1991 to December 25, 1996. The possible reason may be due to the relatively low development level and small scale of China stock market and more restrictions on foreign investments in China for this stage. The period before 1997 is the early developing stage for China stock market. Many problems of emerging China stock markets include its artificial pricing mechanism, the limited number of listed secures and a lack of modern communication facilities and training. On the other hand, from the fundamental situation perspective, the Chinese economy need further open and liberalize its markets to the whole world. So in viewing of both the developing situation of Chinese capital market and fundamental situation of Chinese economy, China stock markets haven't been driven by the global factors—US stock market and UK stock market. Even though many studies indicate that Japanese stock market is one of the most influential one in the world—or we can call Japanese stock market is a major global factor as United States, especially it is premature to conclude that investors who invest in Asian markets can completely ignore the price movement of the Japanese equity market. But from our results, Japanese and China stock markets have the cointegration phenomenon not only because Japan has a huge influence on the global economy and Japanese stock market is one of the major stock markets in the world but more mainly because being the largest market in Asia, its price movements may exert an important impact on the other relatively small Asian stock markets, in the meanwhile Japan and China have a very close economic and trade relation. Hong Kong and Taiwanese stock markets are largest markets just next to Japanese stock markets in South-North Asia. Meanwhile the two regions share a common history with China. For a long time, they keep a close social-economic relationship with China. After China open its gate, the trading and cultural links between China and the two regions increase more and faster. At the first stage of China development, the two regions keep the second and third trading partner of China respectively just next to Japan. So cointegration relationships between China stock market and the three regional counterparts have appeared.

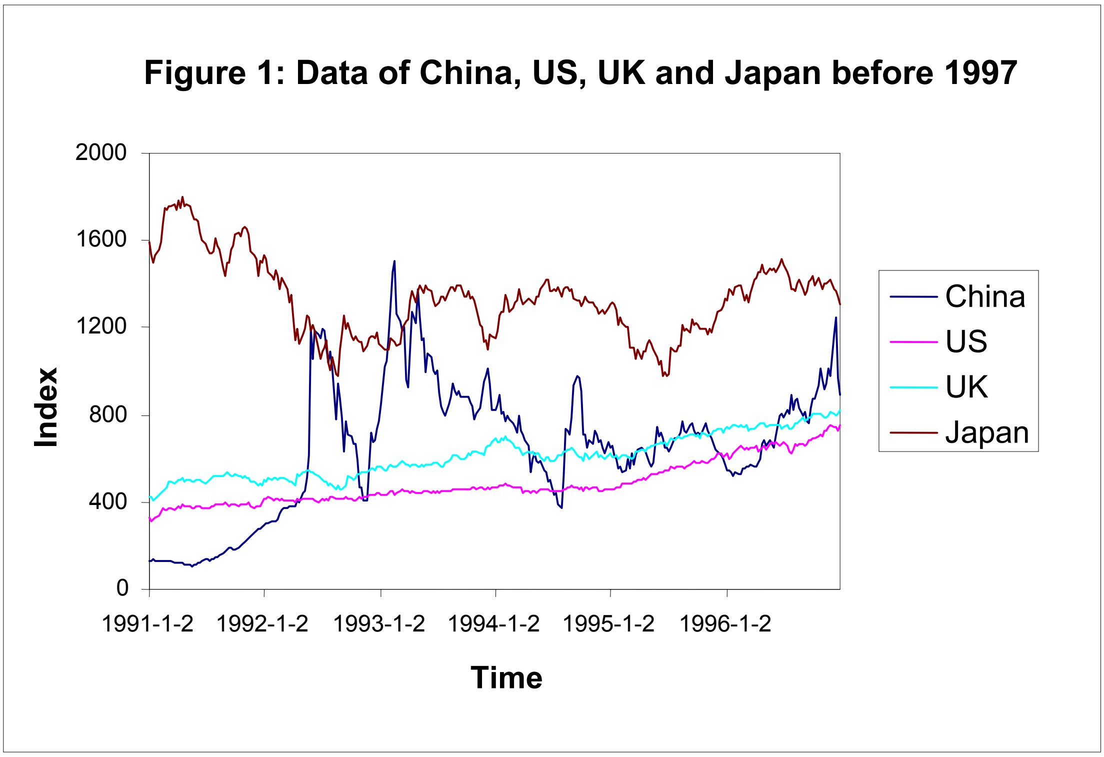
Figure 1: Data of China, US, UK and Japan before 1997
Index
2000
1600
1200
800
400
0
1991-1-2
1992-1-2
1993-1-2
1994-1-2
1995-1-2
1996-1-2
Time
China
US
UK
Japan

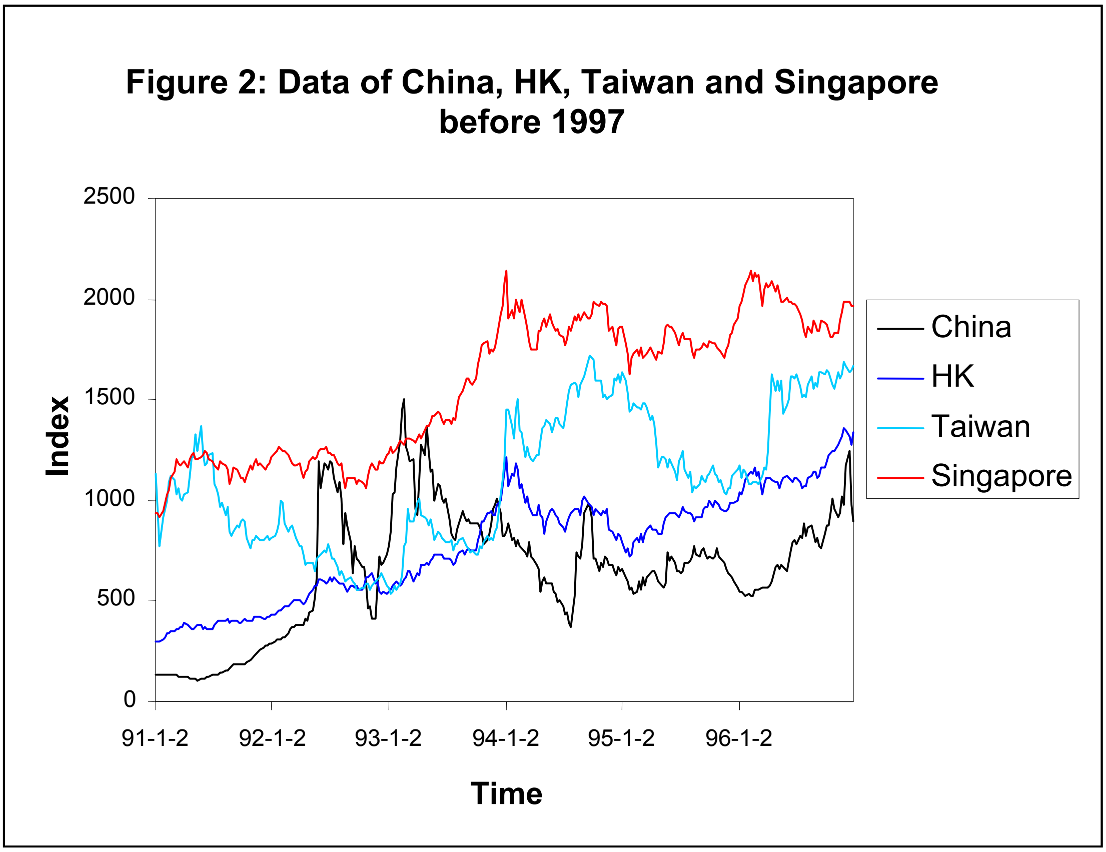
Figure 2: Data of China, HK, Taiwan and Singapore before 1997
Index
2500
2000
1500
1000
500
0
91-1-2
92-1-2
93-1-2
94-1-2
95-1-2
96-1-2
Time
China
HK
Taiwan
Singapore

Figure 3 and Figure 4[6] plot the weekly observations of national stock price indices of two groups (US, UK, Japan and China) (Hong Kong, Taiwan, Singapore and China). In the two figures, weekly stock indices of the selected seven markets have been rescaled in order to show clearer commovements.

4.1.3. Robustness of cointegration results

4.1.3a. Cointegration test using the data in US dollar

In order to check the robustness of the results above, we change all the data in domestic currencies into the data in US dollar. Local currencies show the transmission of shocks between markets, and maybe more appropriate for an investor with a global or multicurrency frame of reference for any investors who are trading with US currency. Returns in US dollar are most useful for comparing international investment activities and opportunities. So except domestic currencies, we also use US dollar returns in this analysis of the linkages of China stock market with the global markets and the regional markets. In details, we restart the cointegration test by the same steps as above to generate the table 3 and table 4. From the results of unit root test, the seven time series still follow the unit root, or I(I) at 5% significant level as before. After establishing that all of the individual time series are from the same data generating process, that is, same order of integration, we can proceed to test if the national equity market indices form a cointegration relationship with a stationary error term. The CRDF and CRADF results of the six series (residuals from equation (1)) are all less than the results using data in

[6] The data showed in Figure 1 and 2 have been rescaled in order to give clearer trends.

domestic currencies compared to the results in different domestic currencies. US, UK and Singapore stock markets are more segmented with China stock markets. Hong Kong and Taiwan stock markets are isolated from China stock market even though they are cointegrated with China stock market by testing the data in local currencies. Only Japan stock market still has cointegration with China stock markets but the financial integration levels of the two equity markets with Chinese market are downgrade. Several possible reasons lead to the less financial integration phenomena. One reason is that the domestic currency of China, the Chinese Yuan (or Renminbi), is not freely convertible, so domestic investors cannot freely buy foreign exchange. In addition, since the opening of the China stock markets for B shares in 1992, domestic and foreign investors were totally segmented by the restrictions that domestic investors can only trade A shares, while foreign investors can only trade B shares. Moreover, a domestic investor must open a bank account that is only used for trading B shares in order to be able to trade B shares. Foreign exchange in such an account must be transferred from foreign banks. The minimum amount required is US dollars 1000. What distinguishes the Chinese markets is that A shares have historically been traded at a premium over B shares. In other markets with partial segmentation between domestic and foreign investors through dual classes of shares, foreign shares are typically traded at a premium over domestic shares. In this respect, the China stock markets are clearly different. A share is traded in China Yuan, while B share is traded in foreign currencies, in particular, in US dollar and HK dollar. So China stock market is more relatively segmented from the international markets using the data in US dollar rather than in Chinese local currency, Yuan under the above restrictions and special market phenomena.

Table 3: Unit Root Tests for the weekly stock indices of China, US, UK, Japan, Taiwan, Hong Kong, and Singapore stock market for the period of 02/01/1991-25/12/1996 (In US dollar)

Country	Variable	DF	ADF	Φ_2	Φ_3	PP
China	Shanghai Composite	-1.84	-1.84	0.41	1.91	-2.368952
US	S&P 500	-1.04	-1.04	6.2*	1.02	0.744099
UK	FTSE 100	-1.91	-1.91	2	2.45	-0.678828
Japan	Nikkei 225 Stock Average	-2.29	-2.74	0.03	2.62	-2.542739
Taiwan	Taiwan SE Banking & Insurance	-2.39	-2.39	0.53	3.12	-2.596834
Hong Kong	Hang Seng	-2.58	-2.58	3.78	3.6	-2.432585
Singapore	Straits Times Index	-1.9	-1.9	3.1	2.7	-2.193906

DF is the Dickey-Fuller t-statistic; **ADF** is the augmented Dickey-Fuller statistic.

DF & ADF for n=250 critical values at 1% = -3.99 and at 5% =-3.43, from Table D.7, Gujarati (2003), Basic Econometrics, 4th ed.

Φ2 and Φ3 are the Dickey-Fuller likelihood ratios. The critical values for them at 5% are 4.75 and 6.34 and at 1% are 6.22 and 8.43 respectively, for n=250.

For PP Test Statistic, MacKinnon critical values are used for rejection of hypothesis of a unit root. 1% and 5% critical value are -3.9889 and -3.4247. Lag truncation for Bartlett kernel: 5

Table 4: Cointegration Results between China stock market and the selected six economies (In US dollar)

number of observations:339				
Period: 2/1/1991-25/12/1996				
Country	**Model**	R^2	**CRDF**	**CRADF**
US	Y(China)=-1.726010+0.99293Y(U.S.)	0.1513	-1.87	-1.87
UK	Y(China)=-4.44472+1.04260Y(UK)	0.0772	-1.78	-1.78
Japan	Y(China)=-12.57731-1.57570Y(Japan)	0.1267	-2.16*	-2.16*
Taiwan	Y(China)=-5.24559-0.21756Y(Taiwan)	0.0132	-1.9	-1.9
Hong Kong	Y(China)=-0.86619+0.76949Y(HK)	0.2872	-1.82	-1.82
Singapore	Y(China)=-0.20713+0.61086Y(Singapore)	0.094	-1.73	-1.73
CRDF is the cointegrating regression Dickey-Fuller statistic for stationarity of the estimated residuals.				
CRADF is the comparable test statistic for the augmented Dickey-Fuller.				
CRDF & CRADF critical values at 5% = -1.95*, 1% = -2.58** from Table D.7, Gujarati (2003), Basic Econometrics, 4th ed.				

4.1.3b. Testing fractional cointegration

Having established the absence of conventional cointegration (Ch-US, Ch-UK and Ch-Singapore), we conduct GPH tests using the residuals of the cointegration equations. The empirical results are summarized in Table 5. When u=0.5 and 0.7, for Ch-US, we can not reject the Null hypothesis: d=1 (alternative is d<1). For the other four u (0.55, 0.575, 0.6, 0.8), the estimates indicate that the residual processe is mean-reverting but non-stationary (0.5<d<1.0). For Ch-UK, when u=0.5, 0.7 and 0.8 we can not reject the Null hypothesis: d=1 (alternative is d<1). For the other three u (0.55, 0.575, 0.6), the estimates indicate that the residual processe is mean-reverting but non-stationary (0.5<d<1.0). For Ch-Singapore, all estimates of the residual processes except when u=0.8 are not mean-reverting (we can not reject null hypothesis d=1). When u=0.8, the estimate indicate that the residule process is mean-reverting but non-stationary (0.5<d<1.0). So from our definition, we can see all the three stock markets are not fractionally cointegrated (0<d<0.5) with China stock market. Therefore, our results from strict cointegration method are confirmed again.

4.1.4. The empirical results of Granger Causality

Since the three stock markets---Japan, Taiwan and Hong Kong stock markets are cointegrated with China stock market at 5% significant level in local currencies, Error Correction Model is employed to test the Granger causality between them. While, for the other three ones---US, UK and Singapore stock markets we use Vector Autoregression Model to find out the Granger causal relations between them. Estimates of linear causality between national stock index returns are reported in Table 6. We show the results both from ECM and from VAR to make a comparison. And the optimal lag results from the minimum final prediction criterion are also shown on table 6. Results indicate that the Japan, Hong Kong and Taiwan lead the China stock market at 6%, 3% and 7% significant level respectively in the long run, but not the US and UK stock markets. Singapore stock market exerts some impact on China stock market in the short run, because no cointegration (long-run equilibrium relationship) exists between Singapore and China stock markets. In addition, the changes in the performance of China stock market have a feedback to Japanese stock market in the short run and to Taiwan stock market in the long-run. In particular, Hong Kong stock market leads China stock market both from the short- and the long-run. These results are not surprising and conform to the previous empirical findings (Phylaktis (1995), Palac-McMiken (1997)). Nevertheless, they deserve further comments.

Table 5: Results of the fractional cointegration tests on the residuals from (1) Using GPH technique[7]

			China-US	
			t-Statistic	
μ	T^u	d	d=1	d=0.5
0.500	18	0.83578	-1.08647	2.22151
0.550	24	0.72980	-2.06416	1.75556
0.575	28	0.73888	-2.15465	1.97111
0.600	32	0.77829	-1.95581	2.45483
0.700	59	0.95088	-0.58836	5.40060
0.800	105	0.89171	-1.73043	6.25909
			China-UK	
			t-Statistic	
μ	T^u	d	d=1	d=0.5
0.500	18	0.85075	-0.98746	2.32051
0.550	24	0.76824	-1.77050	2.04922
0.575	28	0.77205	-1.88090	2.24487
0.600	32	0.79475	-1.81054	2.60009
0.700	59	0.91403	-1.02970	4.95927
0.800	105	0.90057	-1.58893	6.40059
			China-Singapore	
			t-Statistic	
μ	T^u	d	d=1	d=0.5
0.500	18	1.08758	0.57943	3.88740
0.550	24	0.97978	-0.15449	3.66523
0.575	28	0.96286	-0.30647	3.81930
0.600	32	0.95714	-0.37809	4.03254
0.700	59	0.87136	-1.54083	4.44813
0.800	105	0.86790	-2.11090	5.87861

[7] The hypothesis used here are d=1(alternative is d<1) and d≥0.5 (alternative is d≤0.5).

Table 6: Granger Causality Results for China stock market and the Six Stock Markets for the Period of 01/01/1991-25/12/1996

(In domestic currencies)

Country	China	**VAR p-values**	**ECM p-values**	**Error Correction Term p-values**	**Lag from FPE**
U.S.	ch > us	0.3324	0.3915	0.0169	1,1
	us > ch	0.349	0.3587	0.6397	6,1
U.K.	ch > uk	0.19	0.03	0.0378	1,1
	uk > ch	0.2015	0.2082	0.4839	6,1
Japan	ch > jp	0.1115	0.1164	0.059*	1,1
	jp > ch	0.0504	0.0486*	0.4673	6,2
Taiwan	ch > tw	0.3484	0.335	0.0718*	1,1
	tw > ch	0.6924	0.6469	0.073*	6,2
Hong Kong	ch > hk	0.0729	0.0853*	0.033*	1,1
	hk > ch	0.3964	0.3911	0.8428	1,1
Singapore	ch > sg	0.0432*	0.0556	0.0513	1,1
	sg > ch	0.4861	0.4832	0.8114	5,2
ch > xx :	Chinese stock market is Granger caused by other stock market.				
xx > ch :	Other stock market is Granger caused by China stock markets.				
*means have Granger cause, p<0.1.					

4.1.5. Interpretation of Granger Causality results

First consider the lead-lag relationship between the Hong Kong and the China returns. Results indicate the Hong Kong index returns leads China index returns in the long run (from the p-value of Error correction term). Moreover, the some of the dependence is related to contemporaneous correlation between the series (p-value of ECM is significant at 9% significant level). The so strong unilateral influence from Hong Kong stock market to the mainland stock market may be due to several reasons. The open and reform policy has not only renewed traditional social and economic linkages between Hong Kong and the Mainland but also greatly facilitated the intertwining of the two neighboring territories. The opening up of China coincided with a time when Hong Kong was seeking ways to cope with growing competition from countries of the capitalist world and other newly industrializing economies. The combined effect of the forces of globalization and national policy changes has intensified economic interaction between Hong Kong and the emergence of an integrated economic region in southern China. It has been estimated that of the total directly foreign investment received by Guangdong Province in South China, 70 percent came from Hong Kong[8]. From the national point of view, available data clearly identify Hong Kong as the single largest source of foreign direct investment flow into China. From 1992 to 1999, for instance, China received a total of US$282.574 billion foreign direct investment from all over the world. Of this amount, US$ 140.688 billion or 49.7 percent came from Hong Kong alone[9] . From the financial market and capital formation perspective, Hong Kong was developed to be an

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[8] Chen, "China's Growing Integration with the Asia-Pacific Economy," pp.100

[9] China, State Statistical Bureau, *Zhongguo tongji nian jian* 2000(China Statistical Yearbook 2000) (Beijing: China Statistical Press, 2000), pp. 604-609

international financial center staring far back in the middle of the 19th century. Now Hong Kong is the leading market next to Japan stock market in Asia, it is unavoidable to put some impact on China stock market. In this early stage of China development, China stock market is underdeveloped and from some non-economic factors, this period Hong Kong has not returned to China, so the influence from China is relatively weaker than the Britain. That is why so strong unilateral impact from Hong Kong to China stock market but not vice-verse.

The China and Taiwan lead-lag relationship is slightly different. The contemporaneous effect is non-significant. But the long run lead-lag relationship exists if we choose critical value at 10% not 5% significant level. We find also that the nature of the lead-lag relationship is somewhat equivocal since it appears that some feedback is present. Because of historical problem, the mainland of China is very sensitive to Taiwan issues. The leaders of Mainland want to realize economic, cultural and political integration with Taiwan. Some analysts question the feasibility of integration, in light of the disintegrative forces that continue to separate the various elements of the global Chinese community, while others are skeptical of its desirability either for China or the rest of the world. But the economic integration, whereby the various Chinese economies surmount the political boundaries that have divided and isolated them, already is a reality reflected in the enormous inverse in trade between Taiwan and the mainland. This expansion has been facilitated by the cultural ties among geographically separated Chinese societies. A common culture, common language, family ties and ancestral roots have, for the most part, made it easier for Chinese to develop commercial relations with each other than with non-Chinese. Another factor which has encouraged economic integration has been the more conciliatory approach adopted by the principal Chinese economies in recent years. The Beijing hopes that increased economic interaction eventually will bring about the China's reunification. In contrast, Taipei views economic integration as a more feasible and more tolerable form of national unity than any political reunification. Though it is unlikely that mutual economic benefits will lead gradually to a reunified Chinese polity, it is inevitable that the peripheral regions of the mainland will become more and more "contaminated" by Taiwan and the Mainland also play an important role in Taiwanese economy. So the empirical results show a long-run feedback really exists at the 10% level, even though not reach 5% significant level.

The lead-lag relationship between Japan and China shows that Tokyo stock market can move China stock market in the long-run. Many other researchers report similar results about the mean and volatility spillover effects from Japanese stock market on other Asian stock markets. Wu and Su (1998) report that returns in large markets lead to return in small markets and that the Japanese market has a fairly strong influence on other markets in cases where the US market is isolated. Since Japan is a major investor and trading partner and has political influence on many Pacific Basin countries, it is expected that the financial markets of Tokyo will stress on the movements of Shanghai stock market. In addition, due to the size and world economic importance of the Japan stock market, the market potential influence on other markets cannot be ignored. The rank of China's top 10 trade partners remained relatively unchanged in the recent years; Japan is always the largest trade partner with China in the last ten years. Likewise, from the part of Japan, China is her second larger partners. So China has a feedback to Japan stock market, but because of the developing level of China stock market, the impact is in short run. In a word, both China and Japan play very important roles in the region and in the world through inter- and intraregional relations.

Even though cointegration test was reject at 5% critical value between China stock market and Singapore stock market. But from VAR, the messages from the results show the shock to Singapore stock market can affect China stock market in the short run. The possible reason may be the relative mature level of Singapore stock market compared to China stock market. Singapore is a very important trade partner and investors in Asia. Meanwhile, the countries share common culture and geographical proximity.

No Granger causality was found between New York, London markets and China stock market. In summery, before 1997, China stock market is integrated on a regional basis, but not being integrated with the world leaders in the first stage of China Stock market development.

4.2. Empirical results and interpretation for the period after 1997

4.2.1. The results of unit root and cointegration

Table 7 shows the results of testing the order of integration of the seven series for the period of January 1, 1997 to April 30, 2003. We do not reject that there are unit roots for all the seven stock indices in our sample at both 1% and 5% significance levels. This indicates that all series are I(1). Given the results from the unit root tests discussed above, we perform the cointegration tests on the levels (non-stationary form) of stock indices in all seven markets. In the details, having established that the stock indices in our study are all I(1), we then estimate equation (1). We conduct the unit root test on the residuals from the equation (5) to test the cointegration. Table 8 shows that all the six stock markets are cointegrated with China stock market at 5% significant level. Only Hong Kong and

Singapore are cointegrated with China at 1% significant level while Taiwan is very close to it. This significant closer relationship could be related to geographical proximity, partnerships in trade and cultural and historical similarity[10]. In summery, China stock market is linked with the world leaders and other emerging markets in its region through inter- and intraregional equilibrium relationships.

Table 7: Unit Root Tests for the weekly stock indices of China, US, UK, Japan, Taiwan, Hong Kong, and Singapore stock market for the period of 01/01/1997-30/04/2003 (In domestic currencies)

Country	Variable	DF	ADF	Φ_2	Φ_3	PP
China	Shanghai Composite index	-1.89	-1.89	1.17	2.73	-1.141441
US	S&P 500	-1.8	-1.8	2.12	3.87	-1.290306
UK	FTSE 100	-1.92	-1.8	1.81	3.77	-1.617697
Japan	Nikkei 225 Stock Average	-1.71	-1.71	1.58	1.82	-1.725813
Taiwan	Taiwan SE Composite	-2.75	-2.75	0.56	3.99	-1.825536
Hong Kong	Hang Seng	-1.48	-1.64	0.29	1.21	-2.448377
Singapore	Straits Times Index	-1.46	-1.49	0.24	1.08	-1.49528

DF is the Dickey-Fuller t-statistic; ADF is the augmented Dickey-Fuller statistic.

DF & ADF for n=250 critical values at 1% = -3.99 and at 5% =-3.43, from Table D.7, Gujarati (2003), Basic Econometrics, 4th ed.

$\Phi 2$ and $\Phi 3$ are the Dickey-Fuller likelihood ratios. The critical values for them at 5% are 4.75 and 6.34 and at 1% are 6.22 and 8.43 respectively, for n=250.

For PP Test Statistic, MacKinnon critical values are used for rejection of hypothesis of a unit root. 1% and 5% critical value are -3.9889 and -3.4247.
Lag truncation for Bartlett kernel: 5

[10] We also test the cointegration with the combination of three world leaders and three regional counterparts to China respectively and found the similar results.

Table 8: Cointegration Results for China stock market and the Six Stock Markets

(In domestic currencies)

number of observations: 331				
Period: 01/01/1997-30/04/2003				
Country	**Model**	**R^2**	**CRDF**	**CRADF**
US	Y(China) = 3.3791+0.5606Y(US)	0.2437	-1.99*	-1.99*
UK	Y(China) = 4.4635+0.3315Y(UK)	0.068	-2.09*	-2.09*
Japan	Y(China) = 9.4316-0.2220Y(Japan)	0.0746	-2.15*	-2.38*
Taiwan	Y(China) = 9.0059-0.3375Y(Taiwan)	0.1725	-2.34*	-2.34*
Hong Kong	Y(China) = 4.0562+0.3464Y(HK)	0.1226	-2.62**	-2.62**
Singapore	Y(China) = 5.3775+0.2607Y(Singapore)	0.0717	-2.61**	-2.61**
CRDF is the cointegrating regression Dickey-Fuller statistic for stationarity of the estimated residuals.				
CRADF is the comparable test statistic for the augmented Dickey-Fuller.				
CRDF & CRADF critical values at 5% = -1.95*, 1% = -2.58** from Table D.7, Gujarati (2003), Basic Econometrics, 4th ed.				

4.2.2. Interpretation of cointegration results

One possible explanation for the existence of cointegration between China stock market and the others is the continuous deepening economic reform and opening up. After 1997, Chinese economy has been more integrated into the global economy, especially with the world leaders like United States, United Kingdom and Japan, and the regional counterparts such as Hong Kong, Taiwan and Singapore. China's comprehensive national purchasing power has been remarkably strengthened, with its high GDP formed up. China is now one of the largest trading nations in the world. In a word, Chinese has been into its second developing stage. Moreover, as a new member of the WTO, China is a "best" player of the multilateral trade body. China's foreign trade volume is expected to achieve USD600 billion this year[11]. WTO membership helps accelerate China's moving toward market economy. China's labor-intensive exports should enjoy a big market share in the world. China is now one of the high returns investment destinations with her lower labor cost has attracted many foreign investors. FDI in China was increasing rapidly from USD3 billion in 1990 to USD53 billion in 2002. Chinese government has reduced tariff rate and expanded the opening of trade in goods and services. China is progressively liberalizing her service sectors like finance, insurance, telecommunication, transportation, tourism etc. With the economic integration to the world, China stock market is impossible to be isolated completely from the world stock markets, especially the major developed countries and regional partners. All these fundamental economic factors were inevitably reflected in the performance of the China stock market over time.

[11] All data quoted are from China's Ministry of Foreign Trade and Economic Cooperation.

4.2.3. Robustness of cointegration results

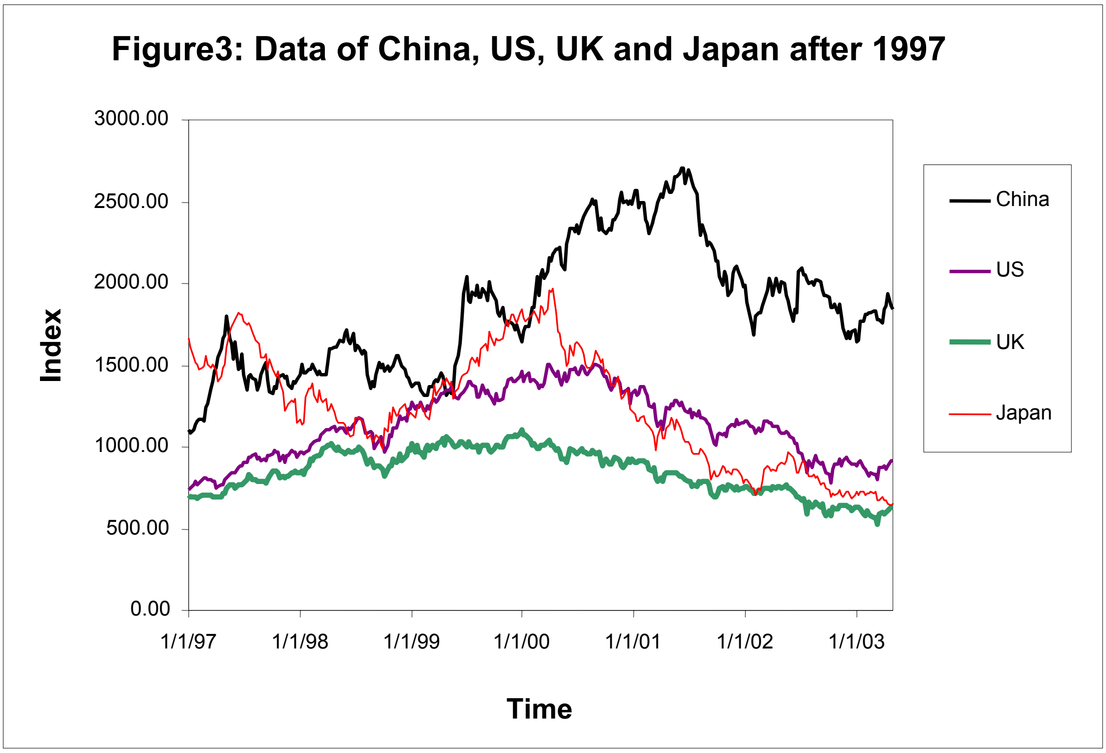
4.2.3a. Multivariate cointegration test

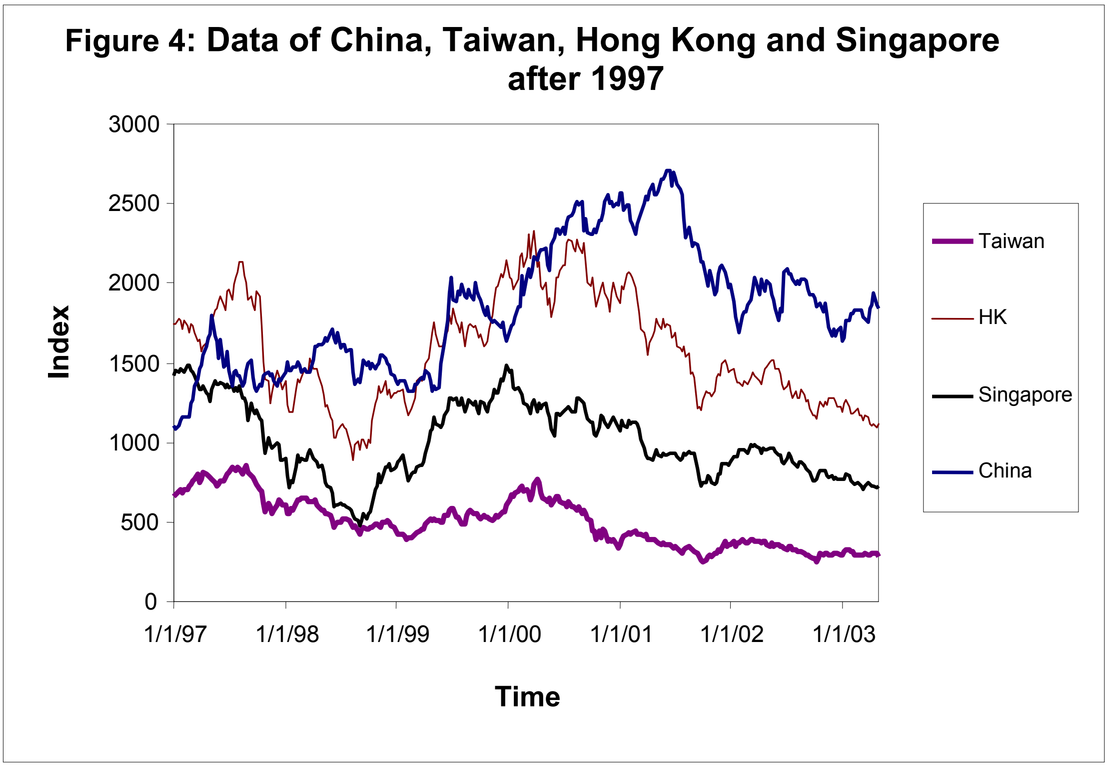
We have tried two alternative specifications in order to check the robustness of the results above. First, we use multivariate cointegration test to find evidence of financial integration in our sample. Out of the seven international stock markets, two sub-groups are also formed. One group contains Chinese regional counterparts (Taiwan, Hong Kong, Singapore).Second group contains the three world leader countries (US, UK and Japan). We also test the total effect of the six national stock markets- the third group-on China stock market. We allow for stock indices in local currencies for the three groups in the cointegrating regression. Table 9 reports that the similar results as before are found. All the three groups are cointegrated with China stock market at 5% significant level, while the subset of regional counterparts and the combination of the six counties are cointegrated with China even at 1% significant level. So in contrast, we find a higher degree of financial integration between China with the regional subset than China with major developed countries. As before, our results suggest that economies that share geographical proximity, common cultural grounds and language besides bilateral trading relationship are connected quite closely. To more directly illustrate potential comovements of the seven stock index series, Figure 3 and Figure 4 plot the weekly observations of national stock price indices in the two subsets and China. Visual inspection of the plot reveals that each series appears to be nonstationary with common trends, and that Chinese stock price series tends to move more together with her counterparts' stock indices than with leader countries'. The only noticeable difference from precious results is the bigger R^2. That is just because the import property of R^2 that it is a nondecreasing function of the number of explanatory variables or regressors present in the model; as the number of regressors increases, R^2 almost invariably increases and never decreases. As the R^2 increase, the fit of our model is said to be "better", more proportion of the variation in Chinese stock index explained by other national stock indices jointly. Our results show the multivariate model contains fewer nonstationary roots than do the univariate models. (From Gujarati (2003), Basic Econometrics, 4th ed. pp.216-217).

Table 9: Cointegration Results for China stock market and the Six Stock Markets in three groups (regional markets; world leaders; all selected markets)

(In US dollar)

Country	Model	R^2	CRDF	CRADF
US, UK, Japan	Y(China)=7.20397+1.36163Y(US)-0.86348Y(UK)-0.21293Y(Japan)	0.4866	-2.44*	-2.44*
Taiwan, Hong Kong, Singapore	Y(China)=3.17899-0.63229Y(Taiwan)+1.17059Y(HK)-0.49710Y(Singapore)	0.6006	-4.14**	-4.14**
US, UK, Japan, Taiwan, Hong Kong ,Singapore	Y(China)=3.14578+0.45442Y(US)-0.05663Y(UK)-0.29162Y(Japan)-0.34131Y(Taiwan)+0.94795Y(HK)-0.39636Y(Singapore)	0.6864	-3.67**	-3.67**
CRDF is the cointegrating regression Dickey-Fuller statistic for stationarity of the estimated residuals.				
CRADF is the comparable test statistic for the augmented Dickey-Fuller.				
CRDF & CRADF critical values at 5% = -1.95*, 1% = -2.58** from Table D.7, Gujarati (2003), Basic Econometrics, 4th ed.				





Note: In the above two figures data have been rescaled in order to give clearer trends

4.2.3b. Cointegration test using the data in US dollar

Table 10: Unit Root Tests for the weekly stock indices of China, U.S., U.K, Japan, Taiwan, Hong Kong, and Singapore stock market for the period of 01/01/1997-30/04/2003 (In US dollar)

Country	Variable	DF	ADF	Φ2	Φ3	PP
China	Shanghai SE Composite	-1.88	-1.88	1.13	2.74	-1.140393
US	S&P 500 Composite	-1.8	-1.8	2.12	3.87	-1.290306
UK	FTSE 100	-2.15	-2.08	1.23	3.62	-2.193863
Japan	Nikkei 225 Stock Average	-1.46	-1.46	1.17	1.26	-1.371997
Taiwan	Taiwan SE Composite +	-2.37	-2.37	0.83	3.88	-3.072109
Hong Kong	Hang Seng	-1.49	-1.65	0.3	1.22	-1.836288
Singapore	Straits Times Index	-1.64	-1.83	0.53	1.36	-1.935468

DF is the Dickey-Fuller t-statistic; **ADF** is the augmented Dickey-Fuller statistic.

DF & ADF for n=250 critical values at 1% = -3.99 and at 5% =-3.43, from Table D.7, Gujarati (2003), Basic Econometrics, 4th ed.

Φ2 and Φ3 are the Dickey-Fuller likelihood ratios. The critical values for them at 5% are 4.75 and 6.34 and at 1% are 6.22 and 8.43 respectively, for n=250.

For PP Test Statistic, MacKinnon critical values are used for rejection of hypothesis of a unit root. 1% and 5% critical value are -3.9889 and -3.4247. Lag truncation for Bartlett kernel: 5

Table 11: Cointegration Results for China stock market and the Six Stock Markets

(In US dollar)

number of observations:331				
Period: 1/1/1997-30/04/2003				
Country	**Model**	**R2**	**CRDF**	**CRADF**
US	Y(China)=1.21885+0.56661Y(US)	0.246	-1.99*	-1.99*
UK	Y(China)=5.32747-0.01473Y(UK)	0.0165	-2.35*	-2.35*
Japan	Y(China)=5.77767-0.12212Y(Japan)	0.0281	-2.21*	-2.37*
Taiwan	Y(China)=5.63293-0.28284Y(Taiwan)	0.1751	-2.22*	-2.22*
Hong Kong	Y(China)=2.7028+0.33572Y(H.K.)	0.1133	-2.62**	-2.62**
Singapore	Y(China)=4.80992+0.05586Y(Singapore)	0.004	-2.42*	-2.42*
CRDF is the cointegrating regression Dickey-Fuller statistic for stationarity of the estimated residuals.				
CRADF is the comparable test statistic for the augmented Dickey-Fuller.				
CRDF & CRADF critical values at 5% = -1.95*, 1% = -2.58** from Table D.7, Gujarati (2003), Basic Econometrics, 4th ed.				

As an additional robustness check, we also test cointegration between China stock market and the other six national stock markets that generated Tables 10 and Table 11. After converting all domestic currency stock indices into the US dollar, we carry on unit test and cointegration analysis using the same steps as before. All the seven series are I(1) at both 1% and 5% significance levels. And all the six countries' stock markets are cointegrated with China stock market. So, on the one hand, we can conclude that only fundamental economic situations influence the performance of the linkages, not exchange rates; on the other hand, the similar results further confirm the robustness of our previous results by domestic currencies. So we further test what is the Granger causality between them.

4.2.4. Empirical results of Granger Causality

Since all the six markets are cointegrated with China at 5% significant level, ECM are employed to test for the Granger causality. We show the results of VAR as well for comparison. The findings reported in Table 12 shows that unilateral causality exists from all the six stock markets to China stock market. Our unreported minimum final prediction error results also have been shown on Table 12. All the six series accept $a_{21} = a_{22} = \cdots = a_{2m} = 0$ but reject a=0. These is the evidence that all the six stock markets Granger cause China stock market and adjust to restore to their long-term equilibrium (from error correction terms) with China stock market.

On the one hand, for the international investors the results indicate that benefits from international portfolio diversification are no longer valid. On the other hand, they indicate that shocks to world leaders and China's regional counterparts can affect the China stock market over the long run. This is very important information for the international investors. Several explanations may account for the casual relationships between the six equity markets and Chinese markets. These possible reasons include economic relationships, regulatory structures, exchange rate policy and trade flows.

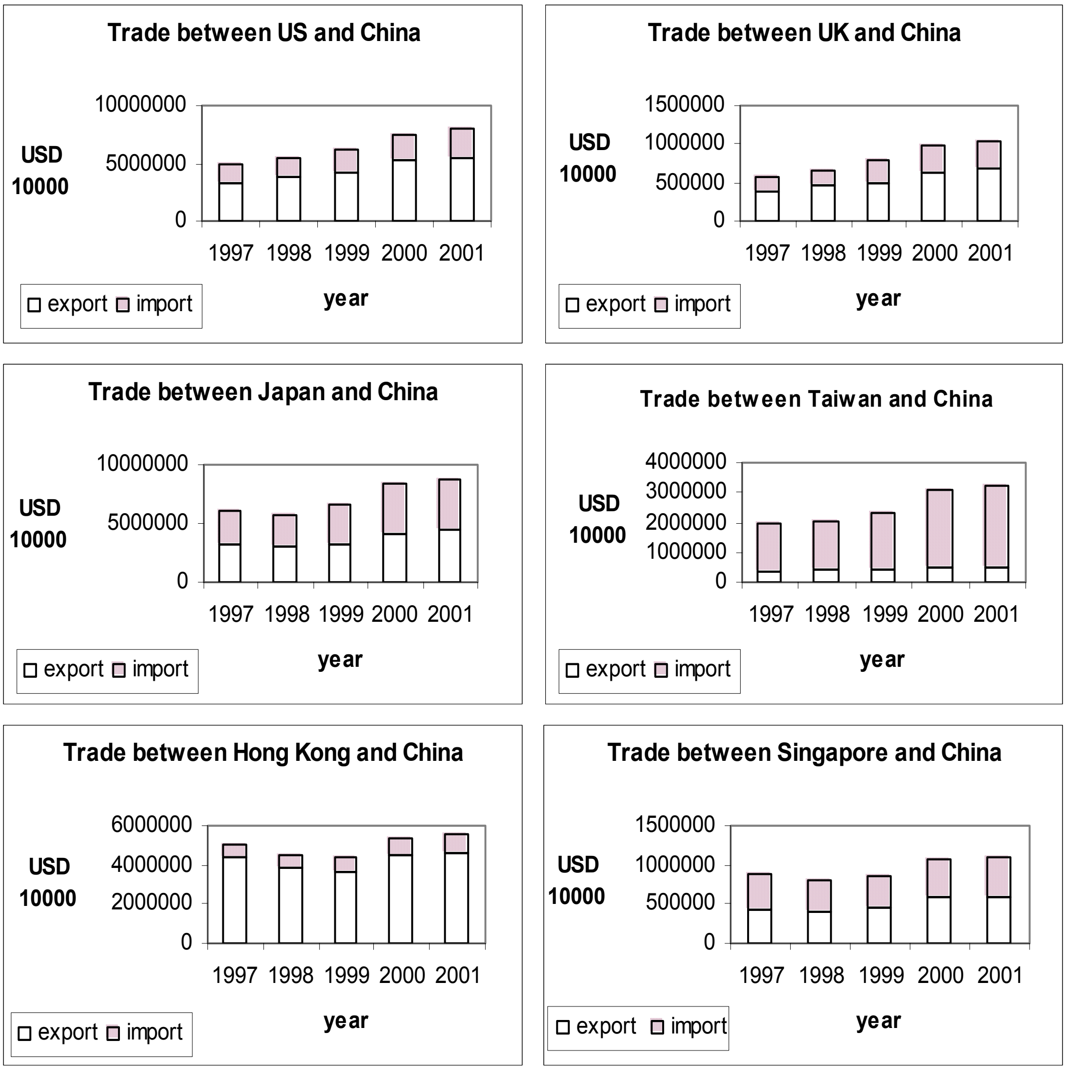
Table 12: Granger Causality Results for China stock market and the Six Stock Markets for the Period of 1/01/1997-30/04/2003

(In US dollar)

Country	China (ch)	VAR p-values	ECM p-values	Error Correction Term p-value	Lag from FPE
US	ch > us	0.5685	0.8478	0.0123*	1,1
	us > ch	0.2872	0.2914	0.6832	1,1
UK	ch > uk	0.2721	0.4942	0.0093**	1,1
	uk > ch	0.3013	0.2983	0.2126	1,1
Japan	ch > jp	0.4887	0.6486	0.0123*	1,1
	jp > ch	0.4586	0.4748	0.4566	1,3
Taiwan	ch > tw	0.0567	0.0998	0.0109*	1,1
	tw > ch	0.7734	0.7685	0.9250	1,1
Hong Kong	ch > hk	0.3777	0.3829	0.0019**	3,1
	hk > ch	0.1515	0.1520	0.6885	4,3
Singapore	ch > sg	0.9403	0.5915	0.0004**	1,1
	sg > ch	0.7149	0.6986	0.3249	5,2
ch > xx :	China stock market is Granger caused by other stock market.				
xx > ch :	Other stock market is Granger caused by China stock market.				
*denotes p<0.05, ** denotes p<0.01.					

4.2.5. Interpretation of Granger Causality results

Figure 5: China's Bilateral Trade with the Six Countries from 1997 to 2001



Source: Ministry of Foreign Trade and Economic Cooperation.

Since the return of Hong Kong in 1997 and Asian financial crisis, for US and China, bilateral trade and economic cooperation have become one of the most important foundations and driving forces of the bilateral relations. As show in Figure 1, the volume of China-US bilateral trade was increased significantly from 1997 to 2001. In addition, by the end of 2002, United States-invested projects in China are USD76.3 billion with contractual and paid-in value of USD40.4 billion. United States is now the second largest trading partner and import source of China in 2003 while China is the fourth largest trade partner of United States. The stock markets of United States as the world's foremost securities market have heavy influence on the world stock market, as well as China stock market.

United Kingdom is one of the earliest western countries traded with the People's Republic of China. United Kingdom is China's second largest trading partner in the European Union. From Figure 5, we can see clearly that the China-UK bilateral trade was increasing dramatically form 1997 to 2001. The rapid economic and trade cooperation between United Kingdom and China has become an important impetus to the overall China-UK relationship. By the end of 2000, United Kingdom has invested nearly USD10 billion in China. The United Kingdom investments are mainly in metallurgic, electronics, textile, shoe-making, apparel, food and marine engineering. As one of the world leaders, UK stock market has completely integrated into the world stock market. This market's potential influence on other markets can not be ignored and there is no doubt that UK stock market Granger cause China stock market.

Japan has remained as China's biggest trade partner for the past ten successive years. The bilateral trade volumes between China and Japan have increased dramatically from 1997 to 2001 as shown in Figure 1. In 2002, the total volume of China-Japan trade grows 16.2%. By September 2002, Japan's actual investment in China was USD35.345 billion. As the regional market force in Asia, Japan has more profound impact on many

Asian economies. Moreover, as a major trading partner and investor, it is expected that the stock market of Japan has influence on China stock market.

Taiwan is the forth trade partner and second import market of China in this period. China is the second export market and the biggest source of trade surplus to Taiwan. With the move towards increasing exchanges, the nature of such activities also became more multi-faceted, which included the flourishing of trade and investment flows across the Straits. Figure 5 also denotes the significant increasing of bilateral trade between them from 1997 to 2001. For 1999 alone, Taiwan's trade with Mainland China makes up 11% of their total external trade. For the same year, China accounts for around 17% of Taiwan's exports. By June 2000, investment from Taiwan to Mainland China was USD15.6 billion. By the end of 2001, accumulative trade across the Strait has reached USD223.26 billion. Beside this, historical relations and culture similarity has tightened up the linkage between the two stock markets.

Hong Kong is the most important entrepot of the Mainland China. About 30% of the Mainland's foreign trade was handled via Hong Kong. According to the Hong Kong government statistics, 90.4% (USD165.7 billion) of Hong Kong's total re-exports (USD183.3 billion in 2002), were either originated from or destined to Mainland China. Hong Kong is the largest source of overseas direct investment in Mainland China. By the end of 2001, 51.3% of the overseas-funded projects registered in Mainland China were tied to Hong Kong's interests. On the other hand, Mainland China is the largest source of inward investment in Hong Kong. The Mainland's cumulative direct investment in Hong Kong was HK$958.1 billion, accounting for 29.3% of Hong Kong's inward direct investment at the end of 2001 (Hong Kong Census and Statistics Department). Hong Kong was the Mainland's third largest trading partner (after Japan and United States) in 2002. Figure 5 shows that the bilateral trade between the Mainland China and Hong Kong was increasing significantly from 1997 to 2001. Mainland China has been Hong Kong's largest trading partner since 1985. Share of the Mainland in Hong Kong's global trade jumped from 9.3% in 1978 to 41.8% in 2002. Mainland China was Hong Kong's largest import source accounting for 44.3% of Hong Kong's total imports, and the largest export market accounting for 39.3% of Hong Kong's total exports in 2002. Hong Kong's trade with Mainland China is to a large extent related to outward processing activities. More than 80% of Hong Kong manufacturers have established production facilities in the Mainland, which have boosted outward processing activities and Hong Kong's re-export growth. All these economic factors were reflected into the performance of Hong Kong and China stock markets.

Recently, trade between China and Singapore developed rapidly. The bilateral trade volume was rising significantly from 1997 to 2001 as shown in Figure 5. Being the sixth largest trading partner of China, Singapore is a traditional market for Chinese export of textile, cereal, edible oil and foodstuff, native produce, and petrol-chemical products. China has increased its export of mechanical and electrical products, telecom equipment, electronic components, metals and minerals, vessels, feedstuff, textile to Singapore. Singapore is the fifth largest foreign investment source in China. By the end of 2000, Singapore's investment in China with a contractual amount of USD35.29 billion and an actual amount of USD16.9 billion. Major projects included Suzhou Industrial Park (SIP), Wuxi Industrial Park, Shanghai Sanlincheng Housing Development project and Dalian Container Wharf. A series of agreements were signed to promote bilateral economic cooperation, such as Agreement on Investment Promotion and Protection, Agreement on Avoidance of Double Taxation and Evasion of Taxation, Agreement on Maritime Transportation, and Agreement on Posts and Telecom Cooperation. With China's unceasingly improvement in the investment climate, the economic and trade relationship between the two countries will be closer and hence improve the linkage between Singapore stock market and China stock market.

All these above explain the existence of Granger causality between the six stock markets and China stock market but can not interpret why the direction is unilateral. Our results in Table 12 show that we fail to reject $H_0: b_{21} = b_{22} = \cdots = b_{2m} = 0$ and b=0. This implies that China stock market do not Granger cause one of the other six stock markets. One possible reason is that the Shanghai stock market was a "policy" market. According to a study conducted in China, over 50% of the significant market movements were caused by changes in trading rules or changes in policies (Jin, 2001). There are evidence to believe that the disconnection between stock returns and the real economic growth in China. For instance, the annual return of Shanghai Composite Index was -4% in 1998 while the GDP growth rate for that year was 7.8%. In 2000, due to a policy shift that favorable to the stock market has caused the annual return of the index achieve a staggering 52% even though the GDP growth for that year was 8%. In 2001, the return of the index swung to -21%, when the government plans to sell a huge number of state-owned shares in the secondary market, while the GDP was 7.3% at that time. Another possible reason is the speculative nature in the Shanghai stock market. Stock prices often do not really reflect the fundamentals of the firms completely. Moreover, China stock market is still in the developing stage and far away from matured to affect other markets in the world.

4.3. Comparison of results before 1997 and results after 1997

We compare the results of data before 1997 and data after 1997, it is very clear that as time passed by, the economic integration between the selected six economies and China is more and more reflected into the financial integration between them through time. The results suggest that an emerging market's sensitivity to shocks from developed markets is related to its degree of openness. From China's perspective, China's development and more liberalization of capital markets contribute to the increasing financial integration. From international perspective, due to the gradual lifting of restrictions on capital flows and the relaxation of exchange controls in many countries, the speed of integration among world capital markets seems to have accelerated. Major progress in computer technology and telecommunication has also expedited the international flow of information and lowered transaction costs. Recent trends of economic unification and regionalization have created various economic blocs that have also contributed to the integration of world capital markets. For each period, the financial integration is more significant on a regional basis than on international basis.

To compare the results in different base currencies, we found that even though no big change in exchange rate structure, but different impact was stressed on the cointegration results for the two sub-periods. China's current unified, managed floating exchange rate regime based on market supply and demand of foreign exchange came into existence in 1994. Between 1994 and 1997, the exchange rate of the RMB against the US dollar appreciated from 8.7:1 to 8.3:1, reflecting the feature of a managed float regime. At the end of 1997, at the request of neighboring economies and international institutions, China substantially narrowed the floating band of the RMB exchange rate to help reduce the shock of the Asian financial crisis and dispel the fear of RMB devaluation. Before 1997, relative fixed exchange rate structure generates less financial integration using data in US dollar, in contrast with the reports in local currencies. While, after 1997, the cointegration results for data in US dollar or in local currencies are relatively unchanged. The economic integration influences the financial integration more than exchange rate structure, even though no big changes in exchange rate structure of China before and after 1997. The results are in line with the overwhelming evidence that financial markets can be integrated when in the presence of substantial foreign exchanged restrictions.(see e.g. Schwert, 1990; Roll, 1992; for the US and Canova and DeNicole, 1995 for the European countries). Empirical studies have confirmed the long–run positive relationship between economic activity and stock prices.

Chapter 5 Conclusions

The economies between China and United States, United Kingdom, Japan, Hong Kong, Taiwan and Singapore have become increasingly integrated with growing bilateral trade and direct investments. In this thesis, we have examined questions whether growing economic integration is reflected in the stock price movements between China stock market and the six typical markets. This research has been motivated by the overwhelming evidence that financial markets can be integrated even in the presence of substantial foreign exchange restrictions. Our results show before 1997, China stock market is segmented from the world leaders and relatively integrated with regional partners. While, after 1997 cointegration exists significantly between China stock market and the six stock markets. This implies that economic integration has been gradually and increasingly reflected into the performance of stock markets in the long run through time. Furthermore, we find that for the whole period financial integration is more significant on a regional basis. This significant closer relationship could be related to geographical proximity, partnerships in trade and cultural and historical similarity. Furthermore, we test Granger causality using data before 1997 and find a feedback between Japan markets & Taiwan markets and China stock markets, while unilateral causal relation exists from Hong Kong markets to China stock markets. This can be due to economic, geographical and cultural reasons. We also find that after 1997 all the six stock markets Granger cause China stock market, but not vice-versa. This unilateral causal relationship may be due to the economic relationships, regulatory structures, exchange rate policy and trade flows between the countries. In addition to their reflection in policy or regulatory changes, China stock market is still in the developing stage to influence others in the world.

The cointegration and Granger causality results presented above have important implications for the global investor. On the one hand, the benefit of international diversification is limited when national equity markets are cointegrated because the presence of common factors limits the amount of independent variation. On the other hand, accounting for the information embodied in the long-run equilibrium relationship, short-run dynamics can be examined to see the process by which the national indices return to their equilibrium states. Thus, in today's global world, the national stock returns can be forecasted by using the error correction mechanisms implied by the cointegration relationships. The short-run interaction between the national stock markets in a regional context and the interaction between the national stock markets and the world leaders can be used for improving forecasts regarding national equity markets.

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